Study on Distribution of Tropical Tropospheric Water Vapor using Global Positioning System (GPS) Radio Occultation (RO) data

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1. Introduction

For characterizing any atmospheric constituent, its vertical resolution should be measured at least 3 times per scale height. Given water vapor 1.5 km average scale height in tropospheric, it should be measured at least once every 4.5 km vertically. Measurement techniques for atmospheric water vapor:

- Ground based: Radiosonde and LIDAR, good vertical resolution but poor spatial resolution.
- Space borne: IR sounders and Microwave sounders, poor vertical resolution and also most of the IR measurements are cloud contaminated, whereas microwave provide good data but over marine environment.
- Unique properties of GPS RO measured water vapor:
  - High accuracy and vertical resolution: With <1 K temperature, <10% humidity, 500 m resolution.
  - Long-term stability.
  - All-weather capability: Can provide data in all weather conditions.
  - Global and even overland: Equal over both ocean and land.

2. GPS Radio Occultation Technique and Algorithm

3. Results

3.1 Typical day-to-day comparison

3.3 Global Validation

4. Global distribution of Relative humidity observed during different seasons

5. Global distribution of Refractivity, Relative Humidity and their comparison with OLR

6. Summary

- Special Radiosonde campaign from July 2006 to March 2007 is conducted at Gadanki to validate the water vapor profiles observed by COSMIC GPS RO.
- A very good comparison in both trend and amplitude is noticed between COSMIC and Radiosonde with temperature difference of 2.2 K. Relative humidity with 5-10% difference.
- The mean and fractional difference of RH in the tropical stations is <10% below 4 K suggesting GPS RO data is most useful below 4 K (assuming Radiosonde is standard).
- The Southern Hemisphere stations like Seychelles, Darwin etc are showing negative bias in water vapor.
- Our simulation studies show that pressure plays a key role in estimating Refractivity.
- The global distribution of RH during different seasons show good correlation with OLR.
- Quite different features in RH during summer and winter are noticed over Indian Subcontinent as expected.
- Our study provides first comprehensive study on validation of water vapor of GPS RO across the globe, suggesting GPS RO as a new tool for monitoring earth's water vapor, hence climate change.